THE ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

U.S. Environmental Protection Agency **NSF International**

ETV Joint Verification Statement

TECHNOLOGY TYPE:	**UPFLOW WATER TREATMENT**	
APPLICATION:	**IN-DRAIN TREATMENT DEVICE**	
TECHNOLOGY NAME:	**UP-FLO™ FILTER WITH CPZ MIX™ FILTER MEDIA**	
TEST LOCATION:	**PENN STATE HARRISBURG**	
COMPANY:	**HYDRO INTERNATIONAL**	
ADDRESS:	**94 Hutchins Drive** **Portland, Maine 04102**	PHONE: **(207) 756-6200** FAX: **(207) 756-6212**
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NSF International (NSF), in cooperation with the U.S. Environmental Protection Agency (EPA), operates the Water Quality Protection Center (WQPC), one of six centers under the Environmental Technology Verification (ETV) Program. The WQPC recently evaluated the performance of the Up-Flo™ Filter, manufactured by Hydro International. The Up-Flo™ Filter was tested at the Penn State Harrisburg Environmental Engineering Laboratory in Midletown, Pennsylvania.

EPA created ETV to facilitate the deployment of innovative or improved environmental technologies through performance verification and dissemination of information. The ETV program's goal is to further environmental protection by accelerating the acceptance and use of improved and more cost-effective technologies. ETV seeks to achieve this goal by providing high quality, peer-reviewed data on technology performance to those involved in the design, distribution, permitting, purchase, and use of environmental technologies.

ETV works in partnership with recognized standards and testing organizations; stakeholder groups, which consist of buyers, vendor organizations, and permitters; and with the full participation of individual technology developers. The program evaluates the performance of innovative technologies by developing test plans that are responsive to the needs of stakeholders, conducting field or laboratory tests (as appropriate), collecting and analyzing data, and preparing peer-reviewed reports. All evaluations are conducted in accordance with rigorous quality assurance protocols to ensure that data of known and adequate quality are generated and that the results are defensible.

TECHNOLOGY DESCRIPTION

The following description of the Up-Flo™ Filter was provided by the vendor and does not represent verified information.

The Up-Flo™ Filter is a passive, modular filtration system that incorporates multiple elements of a treatment train into a single, small-footprint device. The Up-Flo™ Filter uses a sedimentation sump and screening system to pretreat runoff before it flows up through the filter media, housed in one to six filter modules, where final polishing occurs. A high-capacity, siphonic bypass safeguards against upstream ponding during high-flow events. The siphon also serves as a floatables baffle to prevent the escape of floatable trash and debris from the Up-Flo™ Filter chamber.

The Up-Flo™ Filter is self-activating and operates by simple hydraulics. Challenge water enters the chamber from an inlet pipe or an overhead grate and flows into the sump region where gross debris and coarse grit are removed by settling. Runoff continues to fill the chamber until there is enough driving head to initiate flow through the filter media. At this point, the water flows up through the angled screen into the filter module. In the filter module, flow passes up through the filter media and is conveyed to the outlet module via the flow conveyance channel. Flows in excess of the filtration capacity are discharged directly to the outlet module by the siphonic bypass. The siphon also serves as a floatables baffle to prevent the escape of buoyant litter and debris. The Up-Flo™ Filter is equipped with a drain-down mechanism to ensure that the filter media sits above the standing water level during no-flow conditions, to prevent anoxic conditions that could promote bacterial growth in the filter media and the release of harmful leachates. As flows subside, water slowly drains out of the chamber through four small drain-down ports located at the base of the outlet module. The drain-down ports are covered with a layer of filter fabric to provide treatment to the drain-down flows.

Performance of a regularly maintained Up-Flo™ Filter should provide removal of over 80% of total suspended solids (TSS) from challenge water runoff. It will also remove a portion of metals, organics and other pollutants commonly found sorbed to the surface of suspended sediment particles. Each filter module filled with the CPZ Mix™ will have a flow rate of 20-25 gpm when the water level in the chamber provides 20 in. of driving head. Water will continue to be filtered up through the filter media until the water level in the chamber falls to zero inches of driving head. When the inflows exceed the filtration capacity, the excess flows will discharge through the bypass siphon directly to the outlet module.

VERIFICATION TESTING DESCRIPTION

Methods and Procedures

The testing methods and procedures employed during the study were outlined in the *Test Plan for Hydro International, Inc. Up-Flo™ Filter for Stormwater Treatment* (February 2006). The Up-Flo™ Filter was installed in a specially designed testing rig to simulate a catch basin receiving surface runoff. The rig was designed to provide for controlled dosing and sampling, and to allow for observation of system performance.

The Up-Flo™ Filter was challenged by a variety of hydraulic flow and contaminant load conditions to evaluate the system's performance under normal and elevated loadings. The test conditions are summarized in Table 1. Additional tests were conducted at the vendor's request to determine the media's sediment removal capabilities with challenge water consisting of only sediments and nutrients (no hydrocarbons) at continuous flow. The results of these tests will be published in an addendum at a later time.

Table 1. Test Phase Summary

Phase and Flow Condition		Flow	Loadings	Test Duration
I	Intermittent Flow	11 gpm, 15 min on, 15 min off	Normal	40 hr
II	Contaminant Capacity	16 gpm continuous	Normal	Continue until exhaustion
III-1	Hydraulic Capacity, Clean Water	10 to 45 gpm, increased in 5 gpm increments	None	15 min at each flow interval
III-2	Hydraulic Capacity, Synthetic Wastewater	10 to 45 gpm, increased in 5 gpm increments	Normal	15 min at each flow interval
III-3	Hydraulic Capacity, Spiked Wastewater	10 to 45 gpm, increased in 5 gpm increments	Spiked (4X)	15 min at each flow interval
IV	Contaminant Capacity at High Hydraulic Throughput	32 gpm continuous	Normal	Continue until exhaustion

A synthesized wastewater mixture containing petroleum hydrocarbons (gasoline, diesel fuel, motor oil, and brake fluid), automotive fluids (antifreeze and windshield washer solvent), surfactants, and sediments (sand, topsoil and clay), was used to simulate constituents found in surface runoff from a commercial or industrial setting. Influent and effluent samples were collected and analyzed for several parameters, including TSS, suspended sediment concentration (SSC), total phosphorus (TP), and chemical oxygen demand (COD). Complete descriptions of the testing and quality assurance/quality control (QA/QC) procedures are included in the verification report.

PERFORMANCE VERIFICATION

System Installation and Maintenance

The Up-Flo™ Filter was found to be durable and easy to install, requiring no special tools. Maintenance on the system during testing consisted of replacing the filter media bags, and removing sediment and water collected in the sump. Maintenance took approximately 30-45 minutes, with the most difficult activity being removal of the filter media bags, due to their size and weight.

Hydraulic Capacity

The hydraulic capacity of the Up-Flo™ Filter was determined using clean water (Phase III-1), synthetic wastewater (Phase III-2), and synthetic wastewater with spiked constituents (Phase III-3). Capacity was evaluated as a function of influent and effluent flow rates, and water levels in the sump. The testing determined the effluent flow rates were comparable to the influent for all flow rates tested, up to and past the point where the bypass was activated. The hydraulic capacity results are expressed graphically in Figure 1.

An Up-Flo™ with new filter media can accept a hydraulic flow of up to approximately 30 gpm with no bypass, depending on the concentration of contaminants in the wastewater. At flows greater than 30 gpm the water elevation in the sump approaches the bypass siphon elevation, and a portion of the influent flow exits the system as untreated bypass. The maximum treated flow decreases as the filter media trap contaminants, preventing water from flowing through the filter bags. This was particularly evident with the Phase III-3 (spiked contaminant loadings), where the effluent flow diminished prior to eventually reaching bypass conditions.

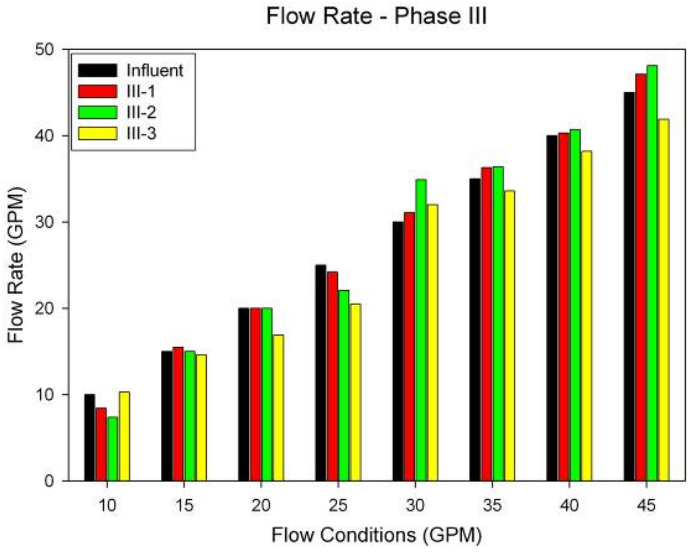

Figure 1. Comparison of influent versus effluent flow rates for Phase III hydraulics testing.

Contaminant Removal

Table 2 summarizes the influent and effluent constituent concentrations and the respective removal efficiencies for the Phase I (intermittent flow) and Phase II (continuous flow tests). During both of these tests, the flow was held constant at 11 gpm for Phase I and 16 gpm for Phase II, both of which are less than the Up-Flo™ Filter's 20 gpm rated capacity. These tests were done consecutively, and were completed when filter media exhaustion or blinding was observed. During testing, the filter media was blinded off by contaminant loading prior to breakthrough occurring. In general, the effluent constituent concentrations remained constant throughout testing.

Table 2. Up-Flo™ Filter Treatment Efficiency Summary for Phase I and Phase II Tests

	Influent Concentration Results (mg/L)				**Effluent Concentration Results (mg/L)**				**Removal Efficiency (%)[1]**			
	Mean	**Median**	**Max.**	**Min.**	**Mean**	**Median**	**Max.**	**Min.**	**Mean**	**Median**	**Max.**	**Min.**
TSS	136	112	492	<5	36	30	100	9	73	73	92	-1,280
SSC	147	130	555	<5	39	30	108	<5	74	77	99	-480
TP	47	44	183	0.6	38	38	81	0.6	19	14	91	-530
COD	157	134	523	60	63	65	89	33	60	51	88	-3.3

1. Mean and median removal efficiencies are calculated using the calculated mean and median influent and effluent concentrations, while maximum and minimum removal efficiencies are evaluated from the paired sample data points.

The median sediment removal efficiency is 73% and 77% for TSS and SSC, respectively, which is slightly below the vendor's 80% sediment removal efficiency performance claim. The Up-Flo™ Filter was also shown to be capable of reducing TP and COD, demonstrated by median removal efficiencies of 14% and 51%, respectively.

Media Blinding/Bypass

During the Phase II and Phase IV tests, the testing organization observed that when the filter media reached capacity, it would shift within the filter module. This shift opened a preferential pathway in the corner of the filter module for water to pass through the system without passing through the filter media. This failure mechanism was not anticipated by the vendor. The vendor indicated that the Up-Flo™ Filter would fail as the filter bags clog, forcing a rise of the water level in the tank to an elevation that would eventually reach the bypass siphon and flow out through the bypass.

Quality Assurance/Quality Control

NSF personnel completed a technical systems audit during testing to ensure that the testing was in compliance with the test plan. NSF also completed a data quality audit of at least 10% of the test data to ensure that the reported data represented the data generated during testing. In addition to QA/QC audits performed by NSF, EPA personnel conducted an audit of NSF's QA Management Program.

Original signed by Sally Gutierrez	*October 15, 2007*	*Original signed by Robert Ferguson*	*October 3, 2007*
Sally Gutierrez	Date	Robert Ferguson	Date
Director		Vice President	
National Risk Management Research Laboratory		Water Systems	
Office of Research and Development		NSF International	
United States Environmental Protection Agency			

Availability of Supporting Documents

Copies of the *Protocol for the Verification of In-Drain Treatment Technologies, April 2001,* the verification statement, and the verification report (NSF Report Number 07/30/WQPC-SWP) are available from:

ETV Water Quality Protection Center Program Manager (hard copy)
NSF International
P.O. Box 130140
Ann Arbor, Michigan 48113-0140

NSF website: http://www.nsf.org/etv (electronic copy)
EPA website: http://www.epa.gov/etv (electronic copy)
Appendices are not included in the verification report, but are available from NSF upon request.